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ELEVATED TEMPERATURE TENSILE AND CREEP BEHAVIOR OF A SiC FIBER-REINFORCED TITANIUM METAL MATRIX COMPOSITE

by

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Abstract

In this research program, the tensile properties and creep behavior in air of $(0)_4$, $(0/90)_s$ and $(90)_4$ SCS-9/Beta 21S composite layups with 0.24 volume fraction fiber were evaluated. Monotonic tensile tests at 23, 482, 650 and 815°C yielded the temperature dependence of the elastic modulus, proportional limit, ultimate tensile strength and total strain at failure. At 650°C, the UTS of the $(0)_4$ and $(0/90)_s$ layups decreases by almost 50% from the room temperature values, indicating that operating temperatures should be less than 650°C to take advantage of the specific tensile properties of these composites.

The strain rate sensitivity of each composite layup was evaluated at 482, 650 and 815°C in additional tensile tests in which the strain rate was instantaneously changed during each test. The $(0)_4$ and $(0/90)_s$ SCS-9/Beta 21S composites show little strain rate sensitivity up to 815°C, as deformation in these layups is dominated by the elastically deforming fiber. The $(90)_4$ composite shows significantly greater strain rate sensitivity which increases with increasing temperature, similar to monolithic Beta 21S material.

Constant load creep tests at 650 and 815°C showed that the $(0)_4$ and $(0/90)_s$ SCS-9/Beta 21S composites exhibit creep behavior modeled by a composite with elastic fibers deforming in a creeping matrix. At 650°C, threshold stress levels for the $(0)_4$ and $(0/90)_s$ composites are approximately 552 and 276 MPa, respectively. In 100-hour creep tests at 650°C, both composite layups exhibit an accumulation in creep strain with time, believed to be due to environmental degradation which results in fiber fracture and cracking. Ultrasonic C-scans show that creep damage is concentrated along the edges of the specimens.

The $(90)_4$ composite exhibits very poor creep resistance at 815°C and also at 650°C at stress levels above the proportional limit. The fibers do enhance the creep resistance of the metal matrix when the fiber-matrix bond is intact. However, at stress levels at which the fibers are debonded from the matrix, the creep rate of the composite is greater than that of the monolithic metal, indicating that the presence of the fibers does not inhibit the deformation of the matrix.

A DC potential drop technique was also used to monitor creep damage and deformation in the composite layups at 650°C in air. The resistivity of the composite specimens does not remain constant during creep tests due to creep damage that occurs early in the test. This change in resistivity will have to be accounted for when quantitatively relating the DCPD recordings to creep mechanisms in these composites.

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